ROUND 9

TOSS-UP

1) Physics – *Multiple Choice* Which of the following is the main reason why metal catches fire if you microwave it, but a chicken nugget doesn't?

W) The glucose in the chicken nugget has a specific heat much higher than metal, causing the metal's temperature to drastically rise while the chicken nugget's temperature rises by a few degrees.
X) Evaporative cooling from the water in the chicken nugget allows the chicken nugget's temperature to raise only a few degrees.
Y) The microwaves released by the microwave increase increase in frequency as the albedo of the substance in the microwave increases
Z) The chicken nuggets do heat up significantly but the autoignition temperature of the chicken nuggets is very high because of the saturated fatty acids in the chicken nugget

ANSWER: X) EVAPORATIVE COOLING FROM THE WATER IN THE CHICKEN NUGGET ALLOWS THE CHICKEN NUGGET'S TEMPERATURE TO RAISE ONLY A FEW DEGREES

BONUS

1) Physics – *Short Answer* What is the total pressure to the nearest atmosphere at a point 100 meters beneath the surface of a large vat of oil using $p = 800\ kg/m^3$?

ANSWER: 9

~~~~~~

TOSS-UP

2) Energy – *Multiple Choice* Scientists at Pacific Northwest National Laboratory are studying how different light sources affect the metabolism of the cyanobacterium *Cyanothece*. Which of the following best explains what use cyanobacteria have in energy production?

W) Cyanobacteria are great sources of biomass for coal production
X) Cyanobacteria are prime candidates for the production of biofuels like hydrogen.
Y) Cyanobacteria are an important component of natural gas.
Z) Areas with high concentrations of cyanobacteria show where oil fields are.

ANSWER: X) CYANOBACTERIA ARE PRIME CANDIDATES FOR THE PRODUCTION OF BIOFUELS LIKE HYDROGEN
~~~~~~

ROUND 9

BONUS

2) Energy – *Short Answer* By name or number, identify all of the following 4 answer choices that are reasons why cyanobacteria are prime candidates for biofuel production: 1) They only require sunlight to photosynthesize, 2) They grow quickly, 3) They can produce large amounts of Hydrogen gas, 4) They are tolerant to extreme environments.

ANSWER: ALL (ACCEPT 1, 2, 3, 4)

ROUND 9

TOSS-UP

3) Chemistry – *Short Answer* What is the K_{sp} of calcium fluoride given that the concentration of fluoride at equilibrium is 2×10^{-4} M (read 2 times 10 to the negative 4 molar)?

ANSWER: 4×10^{-12}

BONUS

3) Chemistry – *Short Answer* To the nearest hundredth, what is the freezing point of a 0.5 *m* (READ 0.5 molal) aqueous solution of NaCl, in degrees Celsius, given the constant K_b is 1.86?

ANSWER: -1.86°C

~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

TOSS-UP

4) Biology - *Multiple Choice* A mother spanks her child for misbehaving. Which form of operant conditioning is the mother using?

W) Positive Reinforcement
X) Positive Punishment
Y) Negative Reinforcement
Z) Negative Punishment

ANSWER: X) POSITIVE PUNISHMENT

BONUS

4) Biology - *Multiple Choice* Which glial cell is responsible for the myelination of the Peripheral Nervous System?

W) Schwann Cell
X) Oligodendrocytes
Y) Microglia
Z) Astrocytes

ANSWER: W) SCHWANN CELL
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

ROUND 9

TOSS-UP

5) Math – *Short Answer* What is the minimum distance between the line 3x - 4y = 15, and the circle $x^2 + y^2 = 4$?

ANSWER: 1

BONUS

5) Math – *Short Answer* In the polar plane, what is the distance between the points (5, 5π/12) and (12, 3π/4)?

ANSWER: $\sqrt{109}$

~~~~~~

TOSS-UP

6) Earth and Space - *Multiple Choice* From which of the following did the solar system and its planets form from?

W) planetary nebulae
X) type 1b supernova
Y) solar nebulae
Z) WHIM

ANSWER: Y) SOLAR NEBULAE

BONUS

6) Earth and Space - *Short Answer* What theory, which may be part of the nebular theory, states that planets form when interstellar dust coalesces because of instabilities in the gravitational field of a solar nebula?

ANSWER: GRAVITATIONAL INSTABILITY THEORY
~~~~~~

ROUND 9

TOSS-UP

7) Energy – *Short Answer* Scientists at Oak Ridge National Laboratory are studying microbial communities from sediments in streams to identify which bacteria are involved in a process that is harmful to the environment. This process converts mercury into what highly toxic form of mercury?

ANSWER: METHYLMERCURY

BONUS

7) Energy – *Short Answer* The mercury that is converted into methylmercury is usually in low concentrations in the environment, but mercury has become a global pollutant due to certain processes. By name or number, identify all of the following 4 processes that are sources of mercury being released into the environment: 1) Burning of coal containing trace amounts of mercury, 2) deforestation, 3) agricultural runoff, 4) metabolism of ruminants.

ANSWER: 1, 3

~~~~~~

TOSS-UP

8) Biology - *Short Answer* What sugar is formed as a result of the energy investment phase of glycolysis?

ANSWER: GADP (ACCEPT GLYCERALDEHYDE 3-PHOSPHATE)

BONUS

8) Biology - *Multiple Choice* Which of the following enzymes is NOT part of the Krebs cycle?

W) Citrate synthase
X) Aconitase
Y) Aldolase
Z) Fumarase

ANSWER: Y) ALDOLASE
~~~~~~

ROUND 9

TOSS-UP

9) Physics – *Short Answer* A projectile is thrown on Earth at an angle of $7\pi/15$ with the horizontal at a speed of 0.9 c. By name or number, which of the following are true: 1) The projectile has an acceleration of 0 at at least one point, 2) The projectile has a velocity of 0 at at least 1 point, 3) The Lorentz factor rounded to the nearest integer is 2?

ANSWER: 3 (ACCEPT: THE LORENTZ FACTOR ROUNDED TO THE NEAREST INTEGER IS 2)

BONUS

9) Physics – *Short Answer* Muons have an average life of $2.2 * 10^{-6}$ seconds in their reference frame, and the distance light travels in $2.0 * 10^{-6}$ seconds is 600 m. If muons travel at a speed of 0.9 c how far do they travel in the reference frame of an observer to the nearest 100 m?

ANSWER: 1400 m

~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

TOSS-UP

10) Chemistry – *Short Answer* If a 10 g piece of magnesium at 20°C, c = 1.0 J/g°C (READ 1.0 joules per gram degree celsius), is placed in 5 g of vegetable oil at 0°C, c = 2.0 J/g°C, what is the equilibrium temperature of the solution, in degrees celsius?

ANSWER: 10°C

BONUS

10) Chemistry – *Short Answer* If the enthalpy of dissociation of NH_4NO_3 is 25 kJ/mol (kilojoules per mole), what is the temperature change of the solution when 1 mole of NH_4NO_3 is dissolved in 1 kg of a solution with a specific heat capacity of 12.5 J/g°C?

ANSWER: -2°C (DO NOT ACCEPT 2°C)

TOSS-UP

11) Math – *Short Answer* What is the space diagonal of a rectangular prism with side lengths 5, 6, and 7 in simplest radical form?

ANSWER: $\sqrt{110}$
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

ROUND 9

BONUS

11) Math – *Short Answer* In rectangle ABCD, AB = 12 and BC = 7. For point E inside the rectangle, AE = 9, BE = 8, and CE = 5. What is DE in simplest radical form?

ANSWER: $\sqrt{42}$

~~~~~~

TOSS-UP

12) Earth and Space - *Short Answer* What is the term for the cloud of gas and dust that forms around the nucleus of a comet as it approaches a star?

ANSWER: COMA (ACCEPT: HEAD)

BONUS

12) Earth and Space - *Short Answer* What is the name of the path a T Tauri star follows on the HR diagram, characterized by a decrease in luminosity at a relatively constant temperature?

ANSWER: HAYASHI TRACK
~~~~~~

ROUND 9

TOSS-UP

13) Biology - *Short Answer* The Young-Helmholtz trichromatic theory proposes that there are three different types of color receptors within the retina, sensitive to which three colors?

ANSWER: RED, BLUE, GREEN IN ANY ORDER

BONUS

13) Biology - *Short Answer* What is the name of the theory that states some optical cells are stimulated by green and inhibited by red, and others are stimulated by red and inhibited by green?

ANSWER: OPPONENT PROCESS THEORY

~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

TOSS-UP

14) Energy – *Multiple Choice* Scientists at Pacific Northwest National Laboratory are studying where tropical cyclones intensify over the ocean. They found out that tropical cyclones intensify considerably over regions in the ocean with a barrier layer. Which of the following best explains a barrier layer?

W) The depth in the ocean where density increases due to a temperature increase while surface salinity remains constant.
X) The depth in the ocean where density increases due to a salinity increase while surface temperature remains constant.
Y) The depth in the ocean where density increases due to a temperature decrease while surface salinity remains constant.
Z) The depth in the ocean where density increases due to a salinity decrease while surface temperature remains constant.

ANSWER: Y) THE DEPTH IN THE OCEAN WHERE DENSITY INCREASES DUE TO A TEMPERATURE DECREASE WHILE SURFACE SALINITY REMAINS CONSTANT

BONUS

14) Energy – *Multiple Choice* Which of the following best explains why tropical cyclones increase over ocean regions with a barrier layer?

W) The instability in a barrier layer allows cool water to raise, cooling surface ocean temperatures.
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

X) The stability in a barrier layer allows cool water to raise, cooling surface ocean temperatures.
Y) The instability in a barrier layer prevents cool water from rising, keeping surface ocean temperatures warm.
Z) The stability in a barrier layer prevents cool water from rising, keeping surface ocean temperatures warm.

ANSWER: Z) THE STABILITY IN A BARRIER LAYER PREVENTS COOL WATER FROM RISING, KEEPING OCEAN TEMPERATURES WARM

ROUND 9

TOSS-UP

15) Physics – *Short Answer* What law relates the speed of a water effusing from a small hole in a container, usually of water, as it reaches the ground, to the height of the hole in the container?

ANSWER: TORRICELLI'S LAW

BONUS

15) Physics – *Short Answer* Identify all of the following 3 statements that are true regarding Bernoulli's principle for water in a non - horizontal pipe: 1) An increase in velocity at equal height will result in a decrease in pressure, 2) An increase in height at constant pressure results in an increase in velocity, 3) A decrease in height may simultaneously cause a decrease in both velocity and pressure?

ANSWER: 1

~~~~~~

TOSS-UP

16) Earth and Space - *Short Answer* What is the term for the depth at which the rate of deposition of calcite is less than or equal to the rate of solvation of calcite in an ocean?

ANSWER: CARBON COMPENSATION DEPTH (ACCEPT: CCD)

BONUS

16) Earth and Space - *Short Answer* The carbon compensation depth varies greatly in different regions of the ocean because of many reasons. By name or number, identify all of the following 5 choices that may affect the carbon compensation depth: 1) Temperature, 2) Amount of argon dissolved in the water, 3) Pressure, 4) Amount of carbon dioxide dissolved in the water, 5) Amount of Ca^{2+} dissolved in the water.

ANSWER: 1, 3, 4, 5 (ACCEPT: ALL BUT 2) (ACCEPT: TEMPERATURE, PRESSURE, AMOUNT OF CARBON DIOXIDE DISSOLVED IN THE WATER, AMOUNT OF CA^{2+} DISSOLVED IN THE WATER)
~~~~~~

ROUND 9

TOSS-UP

17) Chemistry – *Multiple Choice* Which of the following is not a free radical?

W) Hydroxyl
X) Methylene
Y) Superoxide
Z) Ozone

ANSWER: Z) OZONE

BONUS

17) Chemistry – *Multiple Choice* Which of the following is not a type of step in a radical chain reaction?

W) Termination
X) Initiation
Y) Generation
Z) Propagation

ANSWER: Y) GENERATION

~~~~~~

TOSS-UP

18) Math – *Multiple Choice* Triangle ABC has angle A equal to 30 degrees and side AB of length 4. How many integral lengths are possible for side BC?

W) 0
X) 1
Y) 5
Z) Infinitely many

ANSWER: Z) INFINITELY MANY

BONUS

18) Math – *Short Answer* Point Q is chosen at random from inside a regular hexagon ABCDEF of side length 5. What is the probability that angle AQB is obtuse?
~~~~~~

ANSWER: $\frac{\pi\sqrt{3}}{36}$

ROUND 9

TOSS-UP

19) Chemistry – *Short Answer* What is the coordination number of a body-centered cubic unit cell?

ANSWER: 8

BONUS

19) Chemistry – *Multiple Choice* Which of the following unit cells has the highest packing efficiency?

W) Body-centered cubic
X) Hexagonal close-packed
Y) Diamond cubic
Z) Face-centered cubic

ANSWER: Y) DIAMOND CUBIC

~~~~~~

TOSS-UP

20) Physics – *Multiple Choice* Which of the following approximate ranges of wavelengths (in nanometers) does the human eye typically respond to?

W) 220 to 380
X) 380 to 740
Y) 440 to 850
Z) 500 to 820

ANSWER: X) 380 TO 740

BONUS

20) Physics – *Multiple Choice* Which of the following equations, if true, implies perfectly destructive interference?

W)$\lambda(d + ½) = m \cos \theta$ [Lambda times the quantity d plus one-half equals m cosine of theta]
X) $\lambda(d + ½) = m \sin \theta$
Y) $\lambda(m + ½) = d \cos \theta$
~~~~~~

Z) $\lambda(m + ½) = d \sin \theta$

ANSWER: Z) $\lambda(m + ½) = d \sin \theta$

ROUND 9

TOSS-UP

21) Earth and Space - *Multiple Choice* In a process similar to frost wedging, the growth of salt crystals can weather rock as water enters cracks and pores in the rock and evaporates, leaving behind crystals that build up to become big enough to split the rock apart. Which of the following locations is most likely to experience weathering due to salt crystal growth?

W) volcanic mountains
X) hydrothermal vents
Y) rocky shorelines
Z) swamps

ANSWER: Y) ROCKY SHORELINES

BONUS

21) Earth and Space - *Short Answer* By name or number, identify all of the following 4 minerals that typically form clay minerals when eroded: 1) Amphibole, 2) Olivine, 3) Quartz, 4) Feldspar.

ANSWER: AMPHIBOLE, FELDSPAR (ACCEPT: 1, 4)

~~~~~~

TOSS-UP

22) Biology - *Short Answer* The Acid-Growth Hypothesis explained the effects of which hormone on cellular elongation?

ANSWER: AUXIN

BONUS

22) Biology - *Short Answer* What is the name of the hypothesis that there are three genes that regulate formation of floral organs, and each gene is switched on for exactly two specific whorls of the floral meristem?

ANSWER: ABC HYPOTHESIS (ACCEPT ABC)
~~~~~~

ROUND 9

TOSS-UP

23) Math – *Short Answer* How many ways are there for a particle to get to (3, 3) from the origin if it can only go 1 unit up or 1 unit to the right?

ANSWER: 20

BONUS

23) Math – *Short Answer* The equation x = 2 in the Cartesian coordinates can be expressed as $r = f(\theta)$ in polar coordinates. What is $f(\theta)$?

ANSWER: $2\ sec(\theta)$